

Tasks for PATH Decision Analysis of Spring/Summer Chinook

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The purpose of this Decision Analysis Tasklist is to provide an overview of the general plan for PATH decision analyses of Hydro, Habitat, Hatchery, and Harvest management actions. The framework we describe here is continually changing as analyses are completed and direction is received from the Implementation Team and other policy groups. As this plan evolves, we expect that we will be able to provide greater detail on the tasks required, issues associated with these tasks, and options for resolving these issues. Some of these details have been worked out for the Hydro action portion of the decision analysis; these details are provided in the document “Alternative Structures for a Hydro Decision Tree” (preliminary draft released April 18, revised draft in progress).

The task numbers here correspond to the tasks listed on the detailed FY97 PATH Task List distributed yesterday. See that task list for completion deadlines for the tasks described below.

1. Hydro Actions

1.1 Identify alternative management actions

- 1.1.1 Determine required change in productivity to meet NMFS jeopardy standards (done; Deriso et al. “Prospective Analysis of Spring Chinook of the Snake River Basin”)
- 1.1.2 Identify alternative management actions or sets of actions (already done by IT at Feb. 25 meeting)
- 1.1.3 Comments on Hydroregs documentation - The ad hoc Hydro Reg group is responsible for providing hydroreg simulations to PATH for use in passage model runs. This group has released documentation of some of their assumptions in completing these simulations; these should be reviewed by PATH passage modellers.
- 1.1.4 Develop hydro regulation scenarios (in progress, ad hoc Hydro Reg Group). For workshop, it may be faster to use old (i.e. 1995 BiOp scenarios + hydro regs)

1.2 Develop models

- 1.2.1 Identify standard data sets to be used in updated versions of CRiSP and FLUSH:
 - Flows
 - WTT
 - FTT
 - Historical FGEs
 - Transportation data
 - Dam Passage
 - Predation - data on predation rates, effectiveness of predator removal program

- 1.2.2 Develop new versions of CRiSP and FLUSH that incorporate standard data sets
- 1.2.3 Identify reach survival data to be used for qualitative model comparisons. The purpose of these comparisons is to identify similarities and differences between the two models and assess the uncertainties associated with running the two models in the decision analysis.
- 1.2.4 Compare new versions of CRiSP and FLUSH models reach survival data and document.
- 1.2.5 Finalize mechanism for integrating passage model output into the life cycle model

1.3 Identify uncertainties and alternative hypotheses

- 1.3.1 Identify key uncertainties that determine the outcomes of alternative actions. Express each uncertainty in terms of alternative hypotheses (e.g. uncertainty = magnitude of delayed mortality; hypotheses = different magnitudes of delayed mortality under specific management scenarios, or different mechanisms that lead to different magnitudes of delayed mortality).

The main uncertainties identified at the Kah-Nee-Ta workshop were those relating to reservoir mortality (particularly predation mortality) and post-Bonneville mortality of transported and non-transported fish. Additional uncertainties for drawdown (action A3) related to time between decision and implementation, time between implementation and restoration of normative river conditions, and effects on salmon during the transition period.

- 1.3.2 Determine how to represent uncertainties in reservoir survival, post-BON mortality:
 - Reservoir survival - represent uncertainty through changes in parameters in passage models (e.g. FLUSH - A and B parameters in reservoir survival vs FTT relationship; CRiSP - parameters in predation mortality function).
 - Post-BON survival - Hypotheses that relate post-BON mortality to passage through or around the hydro system can be incorporated into the passage models through different assumptions about the survival of transported fish relative to non-transported fish.
Hypotheses about non-hydro mechanisms for post-BON mortality will have to be represented outside the passage models. How this is done remains to be resolved.
- 1.3.3 For uncertainties relating to drawdown - estimate range of possible time lags/interim effects by looking at case studies, predation data, engineering and hydrology studies, etc.

1.4 Estimate probabilities for alternative hypotheses

There are at least two options for how to do this: Option 1 uses the relative fit of different hypotheses incorporated into the passage models to spawner-recruit data to assign probabilities to these alternative models; Option 2 effectively scales passage model output to match the spawner-recruit data, then either assigns equal probabilities to alternative hypotheses or uses other data sets to assign probabilities. More detailed discussion and examples of these options are provided in the "Hydro decision tree" document.

- 1.4.1.1 Option 1: Run new versions of passage models with alternative hypotheses and hydro regulation scenarios to generate vectors (time series) of overall survival (i.e. direct + post-BON) for transported and non-transported fish.
- 1.4.1.2 Option 2: Run new versions of passage models with alternative hypotheses and hydro regulation scenarios to generate vectors (time series) of the ratio of $S_T:S_N$ and P_T , where S_T is survival of transported fish, S_N is survival of non-transported fish, and P_T is the proportion of fish transported.
- 1.4.2.1 Option 1: Incorporate vectors of passage mortalities into MLE model, derive probabilities based on fit to spawner-recruit data (current MLE model calculates likelihoods; calculating posteriors from likelihoods will require some assumptions to be made about priors - probably uniform)
- 1.4.2.2 Option 2: Use the MLE model to estimate separately S_T and S_N , based on $S_T:S_N$, P_T , and overall survival calculated from MLE model. Use other data sets (e.g. reach survival data) to assign probabilities to alternative hypotheses, or assign equal probabilities.

1.5 Calculate performance measures

- 1.5.1 Decide on a set of performance measures (both quantitative and qualitative) and criteria to apply to rank alternative actions. Possible criteria include:
 - Maximize expected value of outcomes for
 - a) all index stocks
 - b) some weighted combination of index stocks to approximate ESU
 - c) weakest stock
 - Maximize the outcome of the worst-case scenario (same a, b, c as above)
 - Action results in a “reasonable” probability of reaching survival/recovery thresholds (yes/no); apply above biological criteria or other socioeconomic criteria to “yes” actions to further rank actions)
 - May not want to take the final step of ranking actions; just present raw results to IT/decision makers and let them decide
 - Present results using different criteria (i.e. results of sensitivity analyses of criteria)

Qualitative performance measures will be derived in consultation with the ISAB based on the Return to the River report. The PATH Planning Group has already met with some members of the ISAB in this regard.

- 1.5.2 Use vectors of passage mortalities in BSM to generate performance measures (Jeopardy Standards, harvest) for each management action and hypothesis.

1.6 Apply criteria and rank actions

Preliminary rankings based on qualitative performance measures can be done while the quantitative performance measures are generated using BSM. Once the quantitative performance measures are available, we will have to integrate them with qualitative measures, possibly using a “multiple accounts” type of approach, where all measures for a particular action are listed in tabular form. Trade-offs between the different performance measures will then have to be made to rank the actions.

1.7 Sensitivity Analyses

Potential sensitivity analyses:

Criteria selected in step 1.5.1 to rank actions

Assumptions made in BSM (e.g. harvest rate schedule)

Sensitivity to data set assumptions in step 1.2.1

1.8 Decision analysis report, integrating results of analyses for all H's.**1.9 Review of analyses by Scientific Review Panel*****Habitat, Hatchery, and Harvest Actions***

At an IT/PATH meeting on April 2, we were informed that the IT is not responsible for compiling a list of habitat, hatchery, or harvest actions for PATH to consider. At the Kah-Nee-Ta workshop and a subsequent meeting with the IT, it was decided that PATH would evaluate the effects of existing plans in these 3 non-hydro H's (e.g. Habitat - USFS and BLM habitat management plans; Hatcheries - Biological Opinion, Recovery Plan; Harvest - input from fish managers), but not develop or evaluate new policies or management actions. We will try to define a range of possible improvements in survival and productivity that might be expected from these existing plans, and integrate these uncertainties into the hydrosystem decision analysis. In effect, this treats the effects of existing plans on stock survival and productivity as an uncertainty node in the hydro decision tree. This will at least provide some guidance on what the effects of different contributions from each of the four H's might have on these standards and other performance measures. Sensitivity analyses will be required to assess how sensitive the conclusions are to assumptions about habitat, hatchery, and harvest actions.

2. Habitat Actions

The main issue in assessing habitat actions through decision analysis is how to describe the possible outcomes of habitat management plans and status quo scenarios (including possible further degradation of some habitats) in terms of quantitative descriptors of stock performance (i.e. Ricker stock-recruitment parameters). Quantitative descriptors of stock performance are required by the Bayesian Prospective Model (BSM) to project numbers of spawners and calculate Jeopardy Standards and other measures of survival and recovery. Along with this requirement is the need to assign probabilities to different magnitudes of stock responses to habitat management plans to allow a probabilistic assessment of the possible outcomes of these actions.

Because there are no models available that allow managers to directly gauge the effects of their plans on habitat quality or quantity in the Columbia River system (unlike hydro actions), the response of stocks to habitat changes, and the uncertainties associated with these responses, must be made using some other, perhaps more qualitative, technique. There are three complementary techniques that could be used to estimate the range of responses to habitat plans (Figure 1).

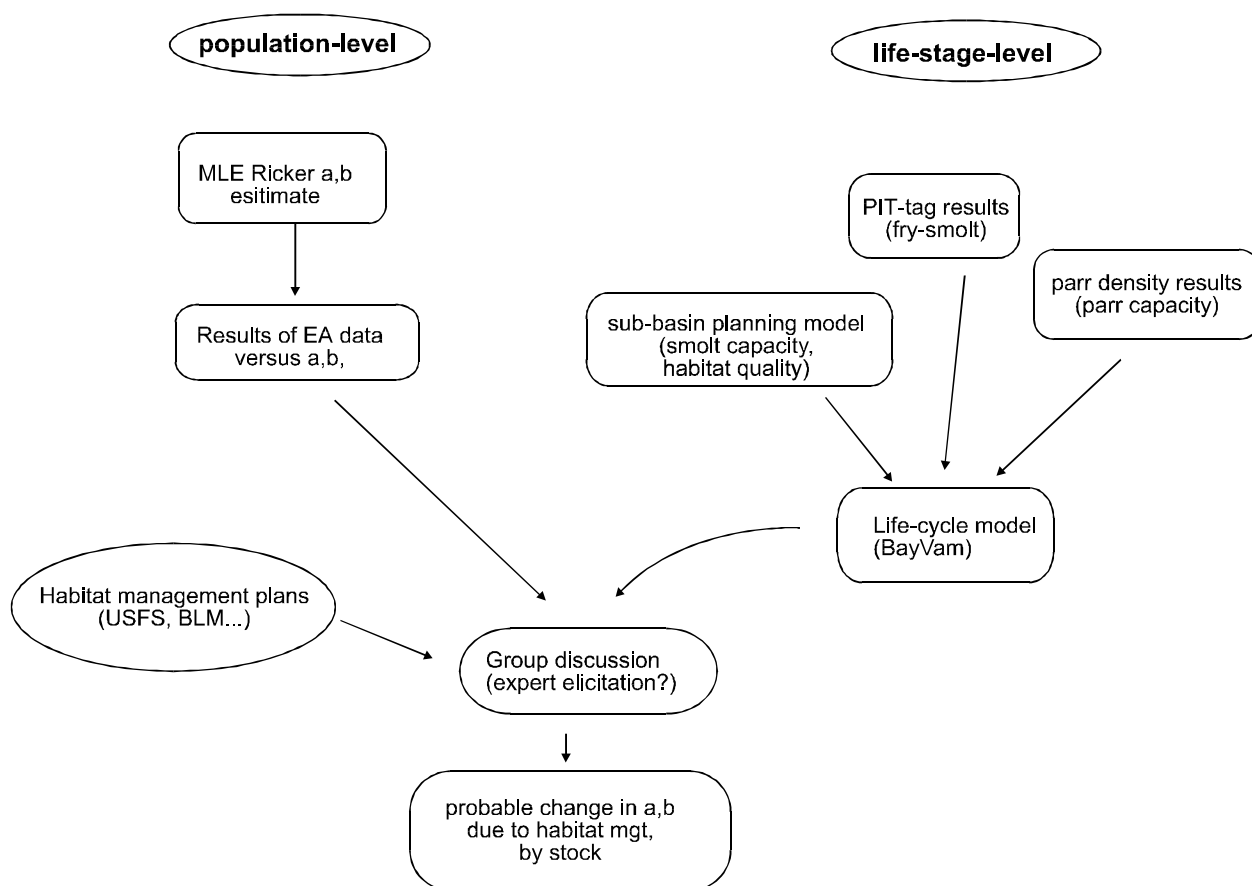


Figure 1: Framework for prospective / decision analysis: habitat

Approach A: Population-Level Analysis

This approach directly compares estimates of Ricker stock-recruitment parameters to various indicators of habitat quality. Run reconstructions are available for 7 Snake River index stocks and are being completed for several more. The major source of habitat data for the analysis comes from the U.S. Forest Service Eastside Assessment work. If consistent relationships between these data and Ricker parameters are observed (i.e., Ricker a values lower in areas with greater disturbance), this provides a means for estimating the possible magnitude of changes in productivity resulting from changes in habitat quality, and the uncertainty associated with those changes.

Issues relating to Approach A:

1. Differences in Ricker parameters among stocks may reflect “intrinsic” differences as well as habitat effects. For example stocks at lower elevations may be generally more productive than those at higher elevations. These differences will confound our comparison of the MLE estimates to the habitat quality ratings, since the latter do not reflect these differences. We may be able to get around this problem by

using the EA data set, which includes several “geographic” variables that could be included in the multivariate analysis.

2. The Ricker parameters are related to both habitat quality and quantity. For example the equilibrium stock size (i.e., carrying capacity) for the Ricker model (form $R = e^a S e^{-bS}$) is given by a/b . Thus it is relatively unlikely that the parameters will be associated with the habitat quality ratings if the stocks differ greatly in habitat quantity. This problem is exacerbated by the fact that there is a strong negative correlation between the a and b parameter estimates, which means that while a/b may be well estimated, several combinations of a and b may be equally likely. At their March 24-25 meeting, the habitat group discussed this issue but were unable to arrive at a satisfactory resolution. Possibilities they are considering include:
 - a) using spawning area estimates (stream length) as an independent estimate of habitat quantity and then combining the habitat quality and quantity estimates and using them as a constraint on the MLE model (e.g., constrain a/b). Then we could see whether the constrained model is much less likely than the unconstrained model.
 - b) using early time series estimates of recruitment (pre-1970) as an estimate of maximum recruitment and use this estimate to constrain the model. For the Ricker model the maximum recruitment is given by $R_{\max} = e^{a-1}/b$.

Approach B: Life-Stage Analyses

Approach “B” attempts to estimate changes in survival rates in freshwater life stages that might result from habitat improvement/restoration measures using three data sources:

- a) Previous sub-basin planning exercises, which relate habitat actions to smolt capacity
- b) PIT-tag data on fry to smolt survival rates
- c) Parr density data

Using these data to estimate changes in life-stage survival rates, changes in overall survival and their associated probability distributions can be estimated using Danny Lee’s Bayesian Belief Network (“BAYVAM”) model or other life-cycle models, if assumptions are made about survival in those parts of the life cycle that are not affected by habitat actions (note that whatever model is used, it must be capable of propagating probabilities associated with changes in life-stage specific survival rates through to the corresponding probabilities of changes in overall survival rate). It would also be useful to judge the time scale over which improvements in survival will be observed. Finally, these changes in overall survival will have to be translated into changes in Ricker stock-recruitment parameters, which can be used in the BSM to project stock performance.

Approach C: Expert Judgement

Approach “C” uses expert elicitation techniques to supplement Approaches A and B where the data are unable to elucidate connections between habitat management actions and changes in stock productivity or survival. This approach would draw on the expertise of PATH scientists to make subjective judgements about the maximum improvement in Ricker stock-recruitment parameters (Approach A) or survival rates in freshwater life stages (Approach B). The latter may be most appropriate for an expert elicitation process if the link between habitat actions and Ricker parameters is too abstract for the experts to conceptualize. There are established techniques for conducting these “expert elicitations”. If necessary, we have included Robin

Gregory, an expert in these techniques, in the ESSA PATH contract for a small amount of time to conduct the elicitations and provide general advice on decision analysis.

Approach A

- 2.A.1 Determine required change in productivity to meet NMFS jeopardy standards (done; Deriso et al. "Prospective Analysis of Spring Chinook of the Snake River Basin").
- 2.A.2 Complete run reconstructions for index stocks.
- 2.A.3 Estimate Ricker parameters.
- 2.A.4 Compile Eastside Assessment, land-use data.
- 2.A.5 Comparison of Ricker parameters to EA data.
- 2.A.6 Based on these comparisons, determine range of possible changes in Ricker parameters (with associated probabilities) that are likely to result from habitat effects. This could be done either within the habitat group or with the assistance of an expert in elicitation techniques.
- 2.A.7 Use changes in Ricker parameters with associated probability distributions in BSM to generate habitat effects on performance measures (integrate into task 1.5.2)

Approach B

- 2B.1 Determine required change in productivity to meet NMFS jeopardy standards (done; Deriso et al. "Prospective Analysis of Spring Chinook of the Snake River Basin")
- 2B.2 Obtain and review previous sub-basin assessment work, parr density data, PIT-tag fry-smolt survival data.
- 2B.3 Use these data to predict range of possible improvements in life-stage survival rates resulting from habitat restoration/protection.
- 2B.4 Use BAYVAM or other models to estimate changes in overall survival and associated probabilities resulting from proposed management actions (expert elicitation may be used here).
- 2B.5 Translate changes in overall survival to changes in Ricker parameters (expert elicitation may be used here).
- 2B.7 Use changes in Ricker parameters with associated probability distributions in BSM to generate habitat effects on performance measures (integrate with task 1.5.2).

Approach C

The schedule of tasks for Approach C will depend on when expert elicitation is needed to supplement analyses used by the other approaches. Task 2A.6, 2B.3, 2B.4, and 2B.5 are the tasks that will probably benefit the most from expert elicitation.

3. Hatchery Actions

The PATH Hatchery workgroup is currently working on several retrospective analyses to test hypotheses about the effects of hatcheries on historical patterns of stock indicators. Once these analyses are completed, they will provide some guidance on possible approaches to incorporating hatchery effects into the decision analysis. A more detailed task list for hatchery decision analysis will be constructed once these retrospective analyses are completed.

As with Habitat, PATH will not try to identify specific management actions for hatcheries at this time. Instead, we will focus our analysis on estimating a range of possible changes (positive and negative) in survival that might be achieved from existing hatchery management plans, then integrating these changes with those expected from other H's to determine their effects on performance measures. Approaches to estimating a range of survival improvements will likely be analogous to approaches to habitat decision analyses, where attempts are made to link hatchery effects either directly to Ricker parameters (analogous to Habitat Approach A) or to survival rates in specific life stages (analogous to Habitat Approach B). Information for making these links will come from retrospective analyses, case studies and literature review, and from expert opinion if more quantitative approaches are not able to produce the information about hatchery effects and their uncertainties that is needed for decision analysis.

- 3.1 Determine what changes in productivity are needed to achieve desired probabilities of reaching survival/recovery thresholds (done; Deriso et al. "Prospective Analysis of Spring Chinook of the Snake River Basin")
- 3.2 Complete retrospective analyses for hatcheries (in progress).
- 3.3 Review possible approaches to conducting hatchery decision analysis and pursue most promising ones.
- 3.4 Use the selected approaches to determine a range of possible changes in productivity or survival (positive or negative) likely to result from hatchery actions, along with the uncertainty associated with those changes (possible need for expert opinion for this)
- 3.5 If changes in life stage survival rates are estimated, translate these to changes to changes in overall survival rates using BAYVAM or other life cycle model, then translate to changes in Ricker parameters (see Habitat actions 2B.4 and 2B.5). Expert opinion will probably be required at this stage.
- 3.6 Use changes in Ricker parameters with associated probability distributions in BSM to generate hatchery effects on performance measures (integrate with task 1.5.2).

4. Harvest Actions

Evaluation of harvest actions has not been a high priority for spring/summer chinook because the harvest rates on these stocks are already low and therefore there is not much opportunity to improve current survival rates by reducing harvest (see Ch. 13, Retrospective Report). However, as stock abundances increase and harvest rates increase accordingly, harvest may become more of a factor in limiting the rate of recovery.

Like habitat and hatchery actions, PATH has not been given a set of alternative harvest actions to evaluate. Thus the first step in any analysis of harvest actions is to identify a plausible range of harvest scenarios (both conservative and aggressive) that might be implemented in the future. This will be done by Tom Cooney in

consultation with the fish managers. This range will bracket the range of possible effects of harvest plans on performance measures. Incorporation of different harvest scenarios into the decision analysis is relatively straight-forward because the harvest rules are already built into the life cycle model.

The task list for harvest actions will be developed as these issues are resolved. Until then, the main task is to scope out the range of possible harvest actions.